

October 11, 2023

Project B2307595

Joe Feriancek, PE
City of Ramsey
7500 Sunwood Drive NW
Ramsey, MN 55303

Re: Pavement Evaluation
Bowers Drive Mill and Overlay Evaluation
US 10 to Cul-de-sac
Ramsey, Minnesota

Dear Mr. Feriancek:

We are pleased to present this Pavement Evaluation Report for the Bowers Drive Mill and Overlay project in Ramsey, Minnesota. The purpose of our evaluation was to extract pavement cores, perform hand auger soil borings, and provide this letter with our recommendations for the project.

We performed our work in general accordance with our Authorization for Services (QTB182268) for the project dated July 28, 2023.

Coring and Hand Auger Borings

In August 2023, we conducted a subsurface investigation by extracting bituminous pavement cores at 11 locations selected by the City of Ramsey. In six of these locations, we extended manual soil borings (hand auger borings) to depths of about 2 feet below the surface. A sketch of these exploration locations is attached to this report.

Table 1 summarizes the bituminous and aggregate base thicknesses as well as the subgrade soils encountered. The table also provides comments on the condition of the bituminous materials. Photos of the cores are attached to this report along with a Descriptive Terminology of Soil for interpreting terms and abbreviations used below.

Table 1. Pavement Core and Hand Auger Boring Summary

Core	Bit. Thickness (inches)	Core Condition	Apparent Aggregate Base Thickness (inches)	Apparent Aggregate Base Layer Description	Subbase/Subgrade Soil
PC-1	3	Crack through core, low-severity stripping	5	Sand and gravel	Silty sand (SM), fine-grained, trace gravel, dark brown, moist (to 26 inches)
PC-2	3 1/2	Cracks through core	**	**	**
PC-3	3 3/4	Crack through core	3	Sand and gravel (fine)	Poorly graded sand (SP), fine-grained, brown, moist (to 26 inches)

Core	Bit. Thickness (inches)	Core Condition	Apparent Aggregate Base Thickness (inches)	Apparent Aggregate Base Layer Description	Subbase/Subgrade Soil
PC-4	3 1/4	Cracks through core, low-severity stripping	**	**	**
PC-5	5	Crack through core, low-severity stripping	12	Sand and gravel	Poorly graded sand with silt (SP-SM), fine-grained, brown, moist (to 28 inches)
PC-6	2 1/4	Cracks through core	**	**	**
PC-7	2 3/4	Cracks through core; high severity stripping, debonding	4	Sand and gravel	Silty sand (SM), fine-grained, dark brown, moist (to 17 inches) Sandy lean clay (CL), brown, moist (17 to 27 inches)
PC-8	3 3/4	Cracks through core	**	**	**
PC-9	2 3/4	Cracks through core; high severity stripping, debonding	4	Sand and gravel	Silty sand (SM), fine-grained, dark brown, moist (to 17 inches) Sandy lean clay (CL), brown, moist (17 to 27 inches)
PC-10	3	Cracks through core; high severity stripping, debonding	**	**	**
PC-11	3 1/2	Cracks through core	24	Sand and gravel	Poorly graded sand (SP), fine-grained, brown, moist (to 36 inches)

**Hand auger not performed

The bituminous materials varied in condition, though many included stripping, cracking, and/or debonding. Stripping nearly always begins at the bottom of the bituminous layer where it may be in contact with saturated aggregate or soil and proceeds upward. Low-severity stripping is common in bituminous pavements over time. However, those that have stripped to moderate or severe degrees should not be considered for rehabilitation methods that may leave the damaged portion of the pavement in place, such as mill and overlay.

The apparent aggregate base was typically thin and consisted of sand/gravel. The aggregate was sometimes underlain by fill material of a similar nature, making it more difficult to distinguish from the aggregate base.

The subgrade soils underlying apparent aggregate base consisted of mainly of granular soils with varying silt content. The exception is PC-7, where we penetrated a layer of sandy lean clay between 17 inches deep and the termination of the hand auger boring.

Discussion and Recommendations

The bituminous materials recovered by coring were mostly thin, and in most cases included cracks through the cores, debonding, stripping, or some combination thereof. A previous overlay was visible in these cores that was usually in better condition than the underlying materials, which are of unknown age.

The service life of a mill and overlay will usually range from about 10 to 16 years with materials in fair or good condition. However, the widespread cracking and material degradation will reduce this service life by several years and can also complicate or slow construction by causing the machine to break through or damage the pavements left in place. A detailed evaluation of pavement surface conditions, which will influence the suitability and service life of the overlay, was outside of the scope of our evaluation. This will be the primary factor influencing the performance of mill and overlay as a rehabilitation option.

If mill and overlay will proceed, we recommend a mill depth of 1 1/2 inches, with a 1 1/2-inch-thick replacement mix meeting SPWEA240B. Thicker mill depths will risk breaking through the thin or damaged areas or will leave too little pavement to support construction equipment.

The risk and additional cost of repairs with additional milling and/or excavation to reach a suitable surface for overlay placement should be considered. This may include repair of severe longitudinal and transverse cracking, alligator/fatigue cracking of any severity, potholes, and other similar failures. MnDOT defines these distresses as follows in their surface rating procedure:

- High-severity linear cracking: Any crack with significant adjacent random cracking (12 inches or more apart), large areas of spalling, missing material and/or potholes.
- Alligator cracking: A series of interconnected cracks forming many-sided, sharp-angled pieces, 6 inches or less in size typically located in the wheelpaths or where traffic loads are concentrated.

We recommend full depth milling or sawcutting and complete removal of pavements exhibiting these conditions, recompaction of the exposed soils and replacement with the same thickness of bituminous materials used for the overlay. We recommend having an experienced engineer walk the milled surface to delineate areas where further repair may be warranted based on conditions exposed by the milling process.

If the potential service life or cost of the mill and overlay as described above is not acceptable, an option is to full depth mill the damaged pavements and replace them with at least 3 inches of SPWEA240C in two lifts. This will provide the opportunity to recompact aggregate materials, test roll and treat soft subgrades and perform fine grading, all of which will contribute to a more uniform pavement section that will have a service life of 15 to 20 years.

All mixes should meet the requirements outlined in MnDOT Specification 2360. We recommend tack coat meeting MnDOT Specification 2357 be placed between the lifts and along vertical faces where paving will match adjacent pavement. We recommend Gyrotory tests on bituminous mixes to evaluate strength and air voids, and density tests to evaluate compaction.

General Remarks

This report is for the exclusive use of the addressed parties. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses, and recommendations may not be appropriate for other parties or projects.

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

We appreciate the opportunity to be of service to you for this pavement evaluation. If you have any questions about this report, please contact Neil Lund at 952.995.2284.

Sincerely,

BRAUN INTERTEC CORPORATION

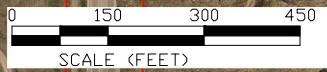
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Neil G. Lund, PE
Technical Manager, Senior Engineer
License Number: 46212
October 11, 2023

Brian J. Schreurs, PE
Account Manager, Senior Engineer

Appendix:

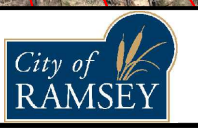
Bowers Drive Pavement Cores Exhibit (provided by City of Ramsey)
Descriptive Terminology of Soil
Core Photo Log



DATE	REVISION

DESIGNED BY: ---
DRAWN BY: ---
CHECKED BY: ---

DATE: 7/25/23
FILE: ---



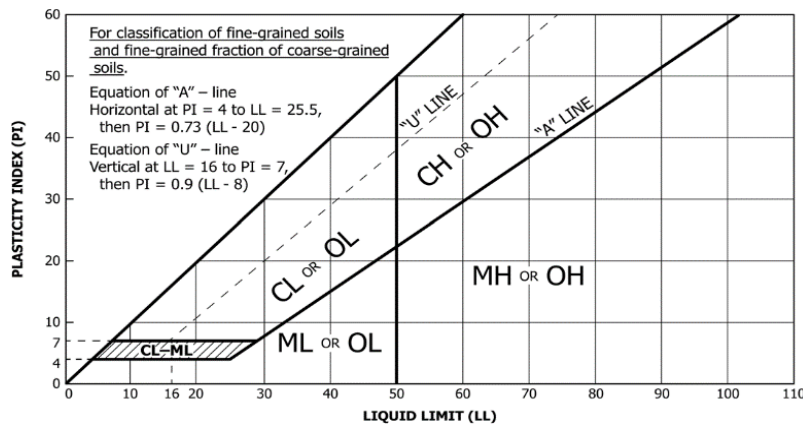
CITY OF RAMSEY
7550 SUNWOOD DRIVE
RAMSEY, MN 55303
(763) 427-1410 FAX (763) 433-9898

BOWERS DRIVE PAVEMENT CORES

--
CITY PROJECT NO. --
CITY OF RAMSEY, MINNESOTA

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A			Soil Classification		
			Group Symbol	Group Name ^B	
Coarse-grained Soils (more than 50% retained on No. 200 sieve)	Gravels (More than 50% of coarse fraction retained on No. 4 sieve)	Clean Gravels (Less than 5% fines ^C)	$C_u \geq 4$ and $1 \leq C_c \leq 3^D$	GW	Well-graded gravel ^E
		Gravels with Fines (More than 12% fines ^C)	$C_u < 4$ and/or ($C_c < 1$ or $C_c > 3^D$)	GP	Poorly graded gravel ^E
			Fines classify as ML or MH	GM	Silty gravel ^{EFG}
		Sands (50% or more coarse fraction passes No. 4 sieve)	Clean Sands (Less than 5% fines ^H)	$C_u \geq 6$ and $1 \leq C_c \leq 3^D$	SW
	Sands with Fines (More than 12% fines ^H)		$C_u < 6$ and/or ($C_c < 1$ or $C_c > 3^D$)	SP	Poorly graded sand ^I
			Fines classify as ML or MH	SM	Silty sand ^{FGI}
	Fines classify as CL or CH		SC	Clayey sand ^{FGI}	
	Fine-grained Soils (50% or more passes the No. 200 sieve)	Silts and Clays (Liquid limit less than 50)	Inorganic	PI > 7 and plots on or above "A" line ^J	CL
PI < 4 or plots below "A" line ^J				ML	Silt ^{KLM}
Organic			Liquid Limit - oven dried	OH	Organic clay ^{KLMN}
			Liquid Limit - not dried < 0.75		
Silts and Clays (Liquid limit 50 or more)		Inorganic	PI plots on or above "A" line	CH	Fat clay ^{KLM}
			PI plots below "A" line	MH	Elastic silt ^{KLM}
		Organic	Liquid Limit - oven dried	OH	Organic clay ^{KLMN}
			Liquid Limit - not dried < 0.75		
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor		PT	Peat	

- A. Based on the material passing the 3-inch (75-mm) sieve.
- B. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
- C. Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
- D. $C_u = D_{60} / D_{10}$ $C_c = (D_{30})^2 / (D_{10} \times D_{60})$
- E. If soil contains $\geq 15\%$ sand, add "with sand" to group name.
- F. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
- G. If fines are organic, add "with organic fines" to group name.
- H. Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
- I. If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.
- J. If Atterberg limits plot in hatched area, soil is CL-ML, silty clay.
- K. If soil contains 15 to < 30% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
- L. If soil contains $\geq 30\%$ plus No. 200, predominantly sand, add "sandy" to group name.
- M. If soil contains $\geq 30\%$ plus No. 200 predominantly gravel, add "gravelly" to group name.
- N. PI ≥ 4 and plots on or above "A" line.
- O. PI < 4 or plots below "A" line.
- P. PI plots on or above "A" line.
- Q. PI plots below "A" line.



DD Dry density, pcf	q_p Pocket penetrometer strength, tsf
WD Wet density, pcf	q_u Unconfined compression test, tsf
P200 % Passing #200 sieve	LL Liquid limit
MC Moisture content, %	PL Plastic limit
OC Organic content, %	PI Plasticity index

Particle Size Identification

- Boulders..... over 12"
- Cobbles..... 3" to 12"
- Gravel
Coarse..... 3/4" to 3" (19.00 mm to 75.00 mm)
Fine..... No. 4 to 3/4" (4.75 mm to 19.00 mm)
- Sand
Coarse..... No. 10 to No. 4 (2.00 mm to 4.75 mm)
Medium..... No. 40 to No. 10 (0.425 mm to 2.00 mm)
Fine..... No. 200 to No. 40 (0.075 mm to 0.425 mm)
- Silt..... No. 200 (0.075 mm) to .005 mm
- Clay..... < .005 mm

Relative Proportions^{L-M}

- trace..... 0 to 5%
- little..... 6 to 14%
- with..... $\geq 15\%$

Inclusion Thicknesses

- lens..... 0 to 1/8"
- seam..... 1/8" to 1"
- layer..... over 1"

Apparent Relative Density of Cohesionless Soils

- Very loose 0 to 4 BPF
- Loose 5 to 10 BPF
- Medium dense..... 11 to 30 BPF
- Dense..... 31 to 50 BPF
- Very dense..... over 50 BPF

Consistency of Cohesive Soils Blows Per Foot Approximate Unconfined Compressive Strength

- Very soft..... 0 to 1 BPF..... < 0.25 tsf
- Soft..... 2 to 4 BPF..... 0.25 to 0.5 tsf
- Medium..... 5 to 8 BPF..... 0.5 to 1 tsf
- Stiff..... 9 to 15 BPF..... 1 to 2 tsf
- Very Stiff..... 16 to 30 BPF..... 2 to 4 tsf
- Hard..... over 30 BPF..... > 4 tsf

Moisture Content:

- Dry:** Absence of moisture, dusty, dry to the touch.
- Moist:** Damp but no visible water.
- Wet:** Visible free water, usually soil is below water table.

Drilling Notes:

Blows/N-value: Blows indicate the driving resistance recorded for each 6-inch interval. The reported N-value is the blows per foot recorded by summing the second and third interval in accordance with the Standard Penetration Test, ASTM D1586.

Partial Penetration: If the sampler could not be driven through a full 6-inch interval, the number of blows for that partial penetration is shown as #/x" (i.e. 50/2"). The N-value is reported as "REF" indicating refusal.

Recovery: Indicates the inches of sample recovered from the sampled interval. For a standard penetration test, full recovery is 18", and is 24" for a thinwall/shelby tube sample.

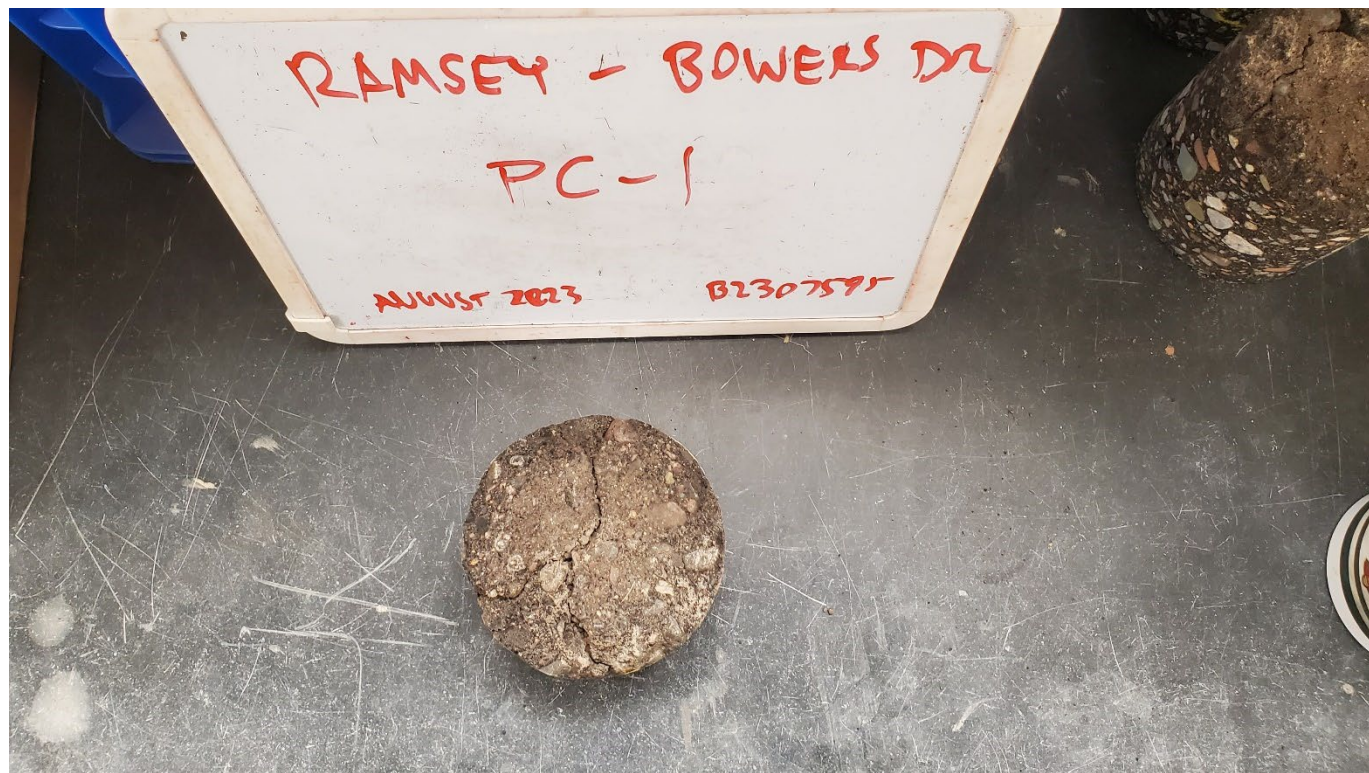
WOH: Indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WOR: Indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

Water Level: Indicates the water level measured by the drillers either while drilling (), at the end of drilling (), or at some time after drilling ().

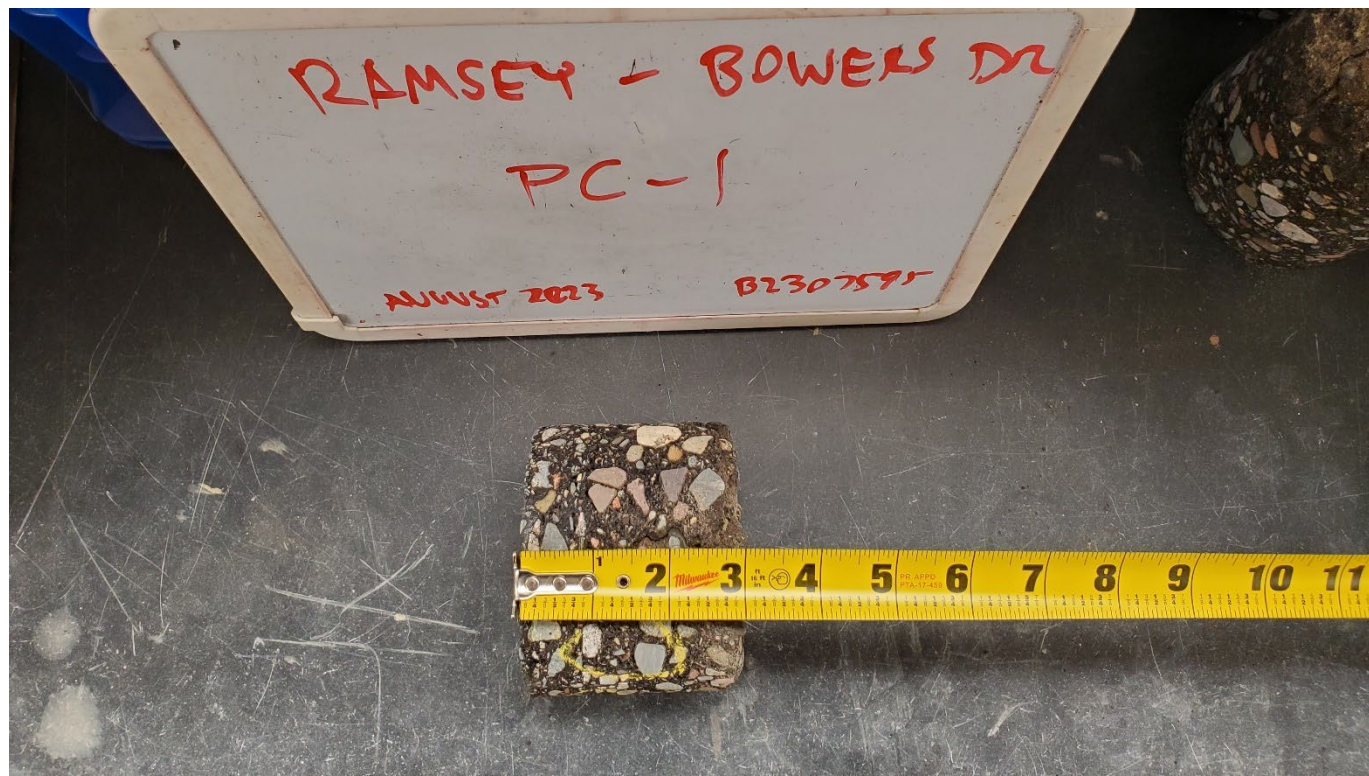
Sample Symbols

Standard Penetration Test	Rock Core
Modified California (MC)	Thinwall (TW)/Shelby Tube (SH)
Auger	Texas Cone Penetrometer
Grab Sample	Dynamic Cone Penetrometer



Core #:	PC-1			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	3 inches	Agg base thickness:	5 inches	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Bottom view



Core #:	PC-1			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	3 inches	Agg base thickness:	5 inches	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Side view



Core #:	PC-2			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	3 1/2 inches	Agg base thickness:	--	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Bottom view. No hand auger completed



Core #:	PC-2			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	3 1/2 inches	Agg base thickness:	--	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Side view. No hand auger completed



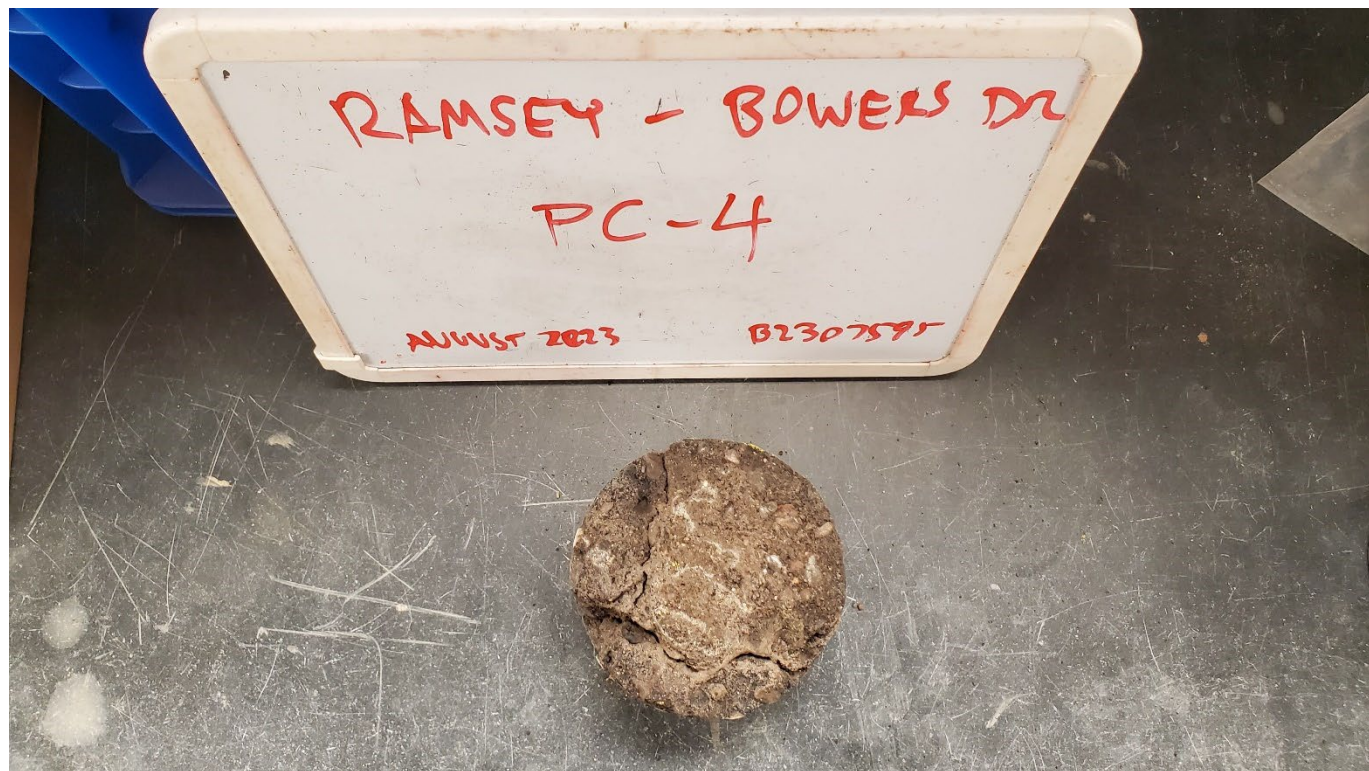
Core #:	PC-3			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	3 3/4 inches	Agg base thickness:	3 inches	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Bottom view



Core #:	PC-3			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	3 3/4 inches	Agg base thickness:	3 inches	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Side view



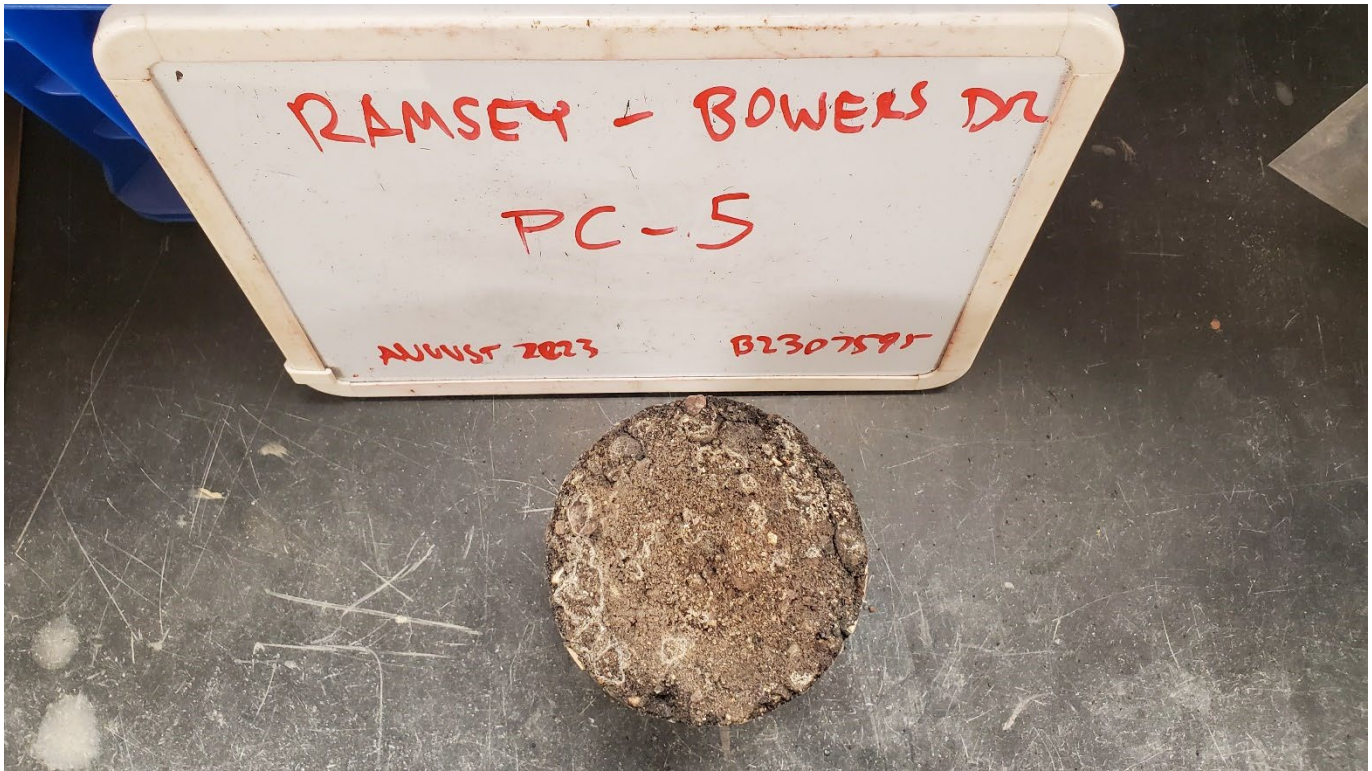
Core #:	PC-4			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	3 1/4 inches	Agg base thickness:	--	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Bottom view. No hand auger completed



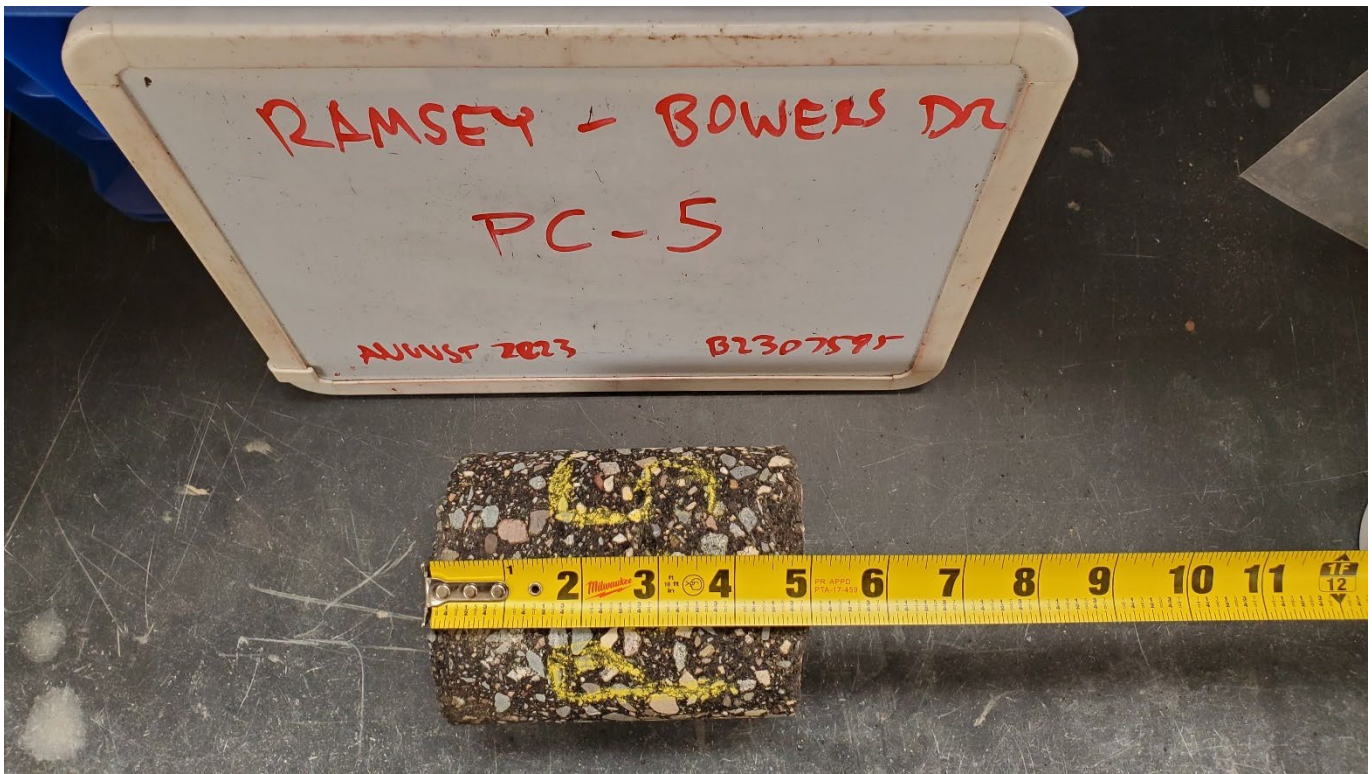
Core #:	PC-4			Project: B2307595 BRAUN INTERTEC
Pavement thickness	3 1/4 inches	Agg base thickness:	--	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes:



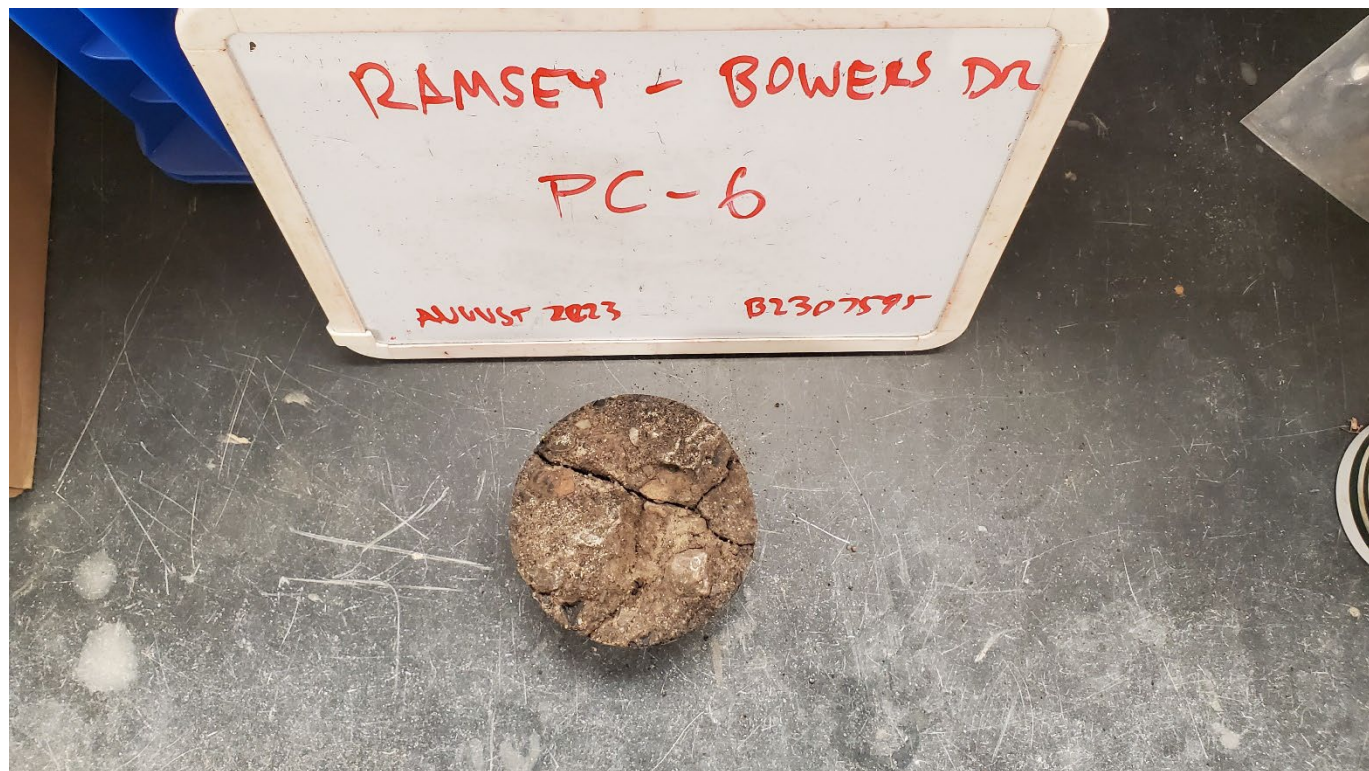
Core #:	PC-5			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	5 inches	Agg base thickness:	12 inches	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Bottom view



Core #:	PC-5			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	5 inches	Agg base thickness:	12 inches	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Side view



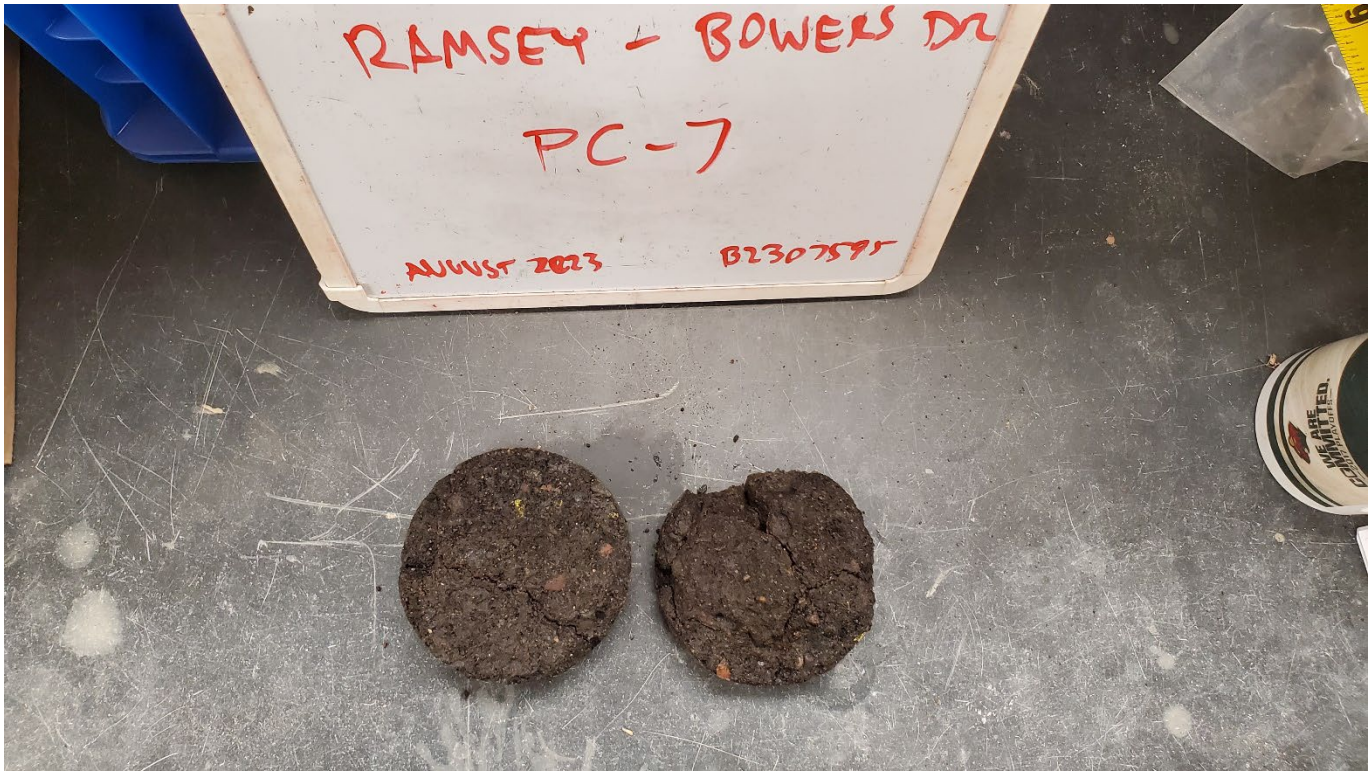
Core #:	PC-6			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	2 1/4 inches	Agg base thickness:	--	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Bottom view. No hand auger completed



Core #:	PC-6			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	2 1/4 inches	Agg base thickness:	--	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Side view. No hand auger completed



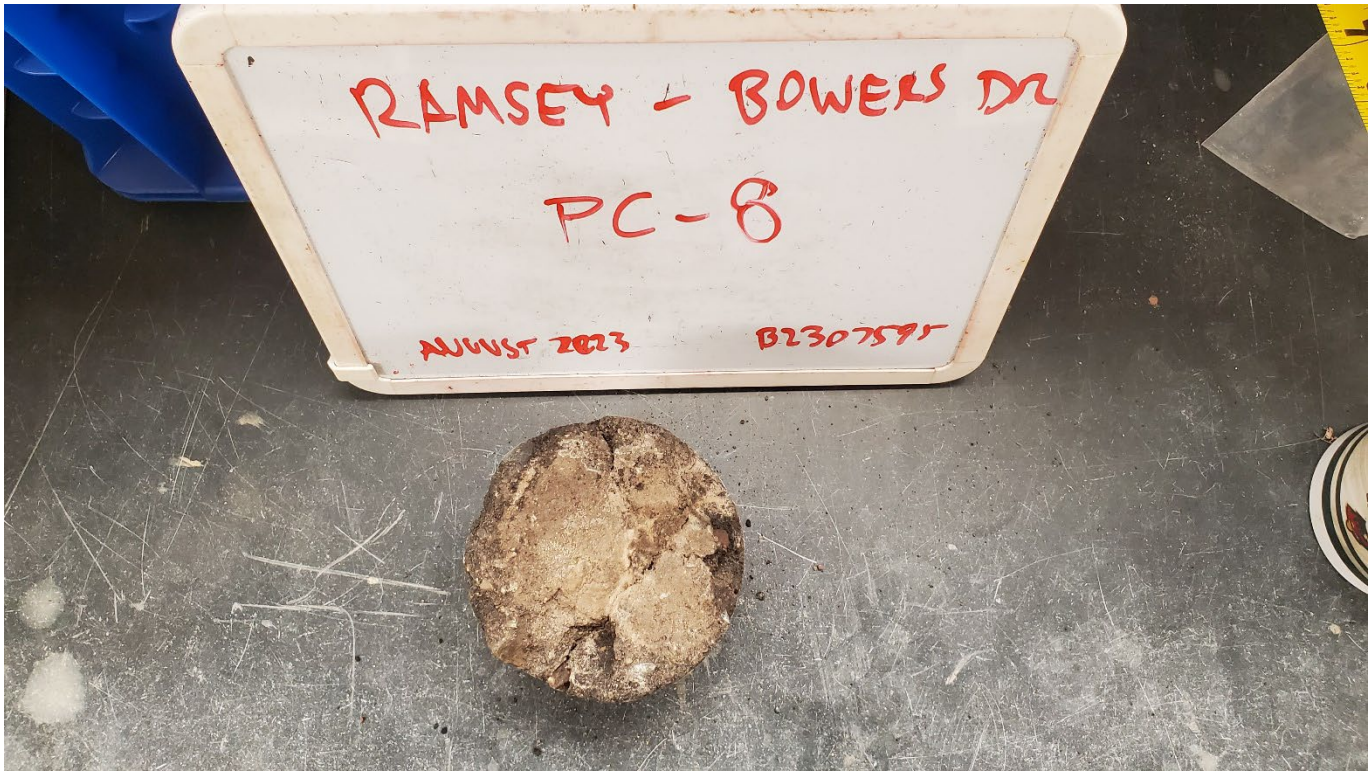
Core #:	PC-7			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	2 3/4 inches	Agg base thickness:	4 inches	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Bottom view



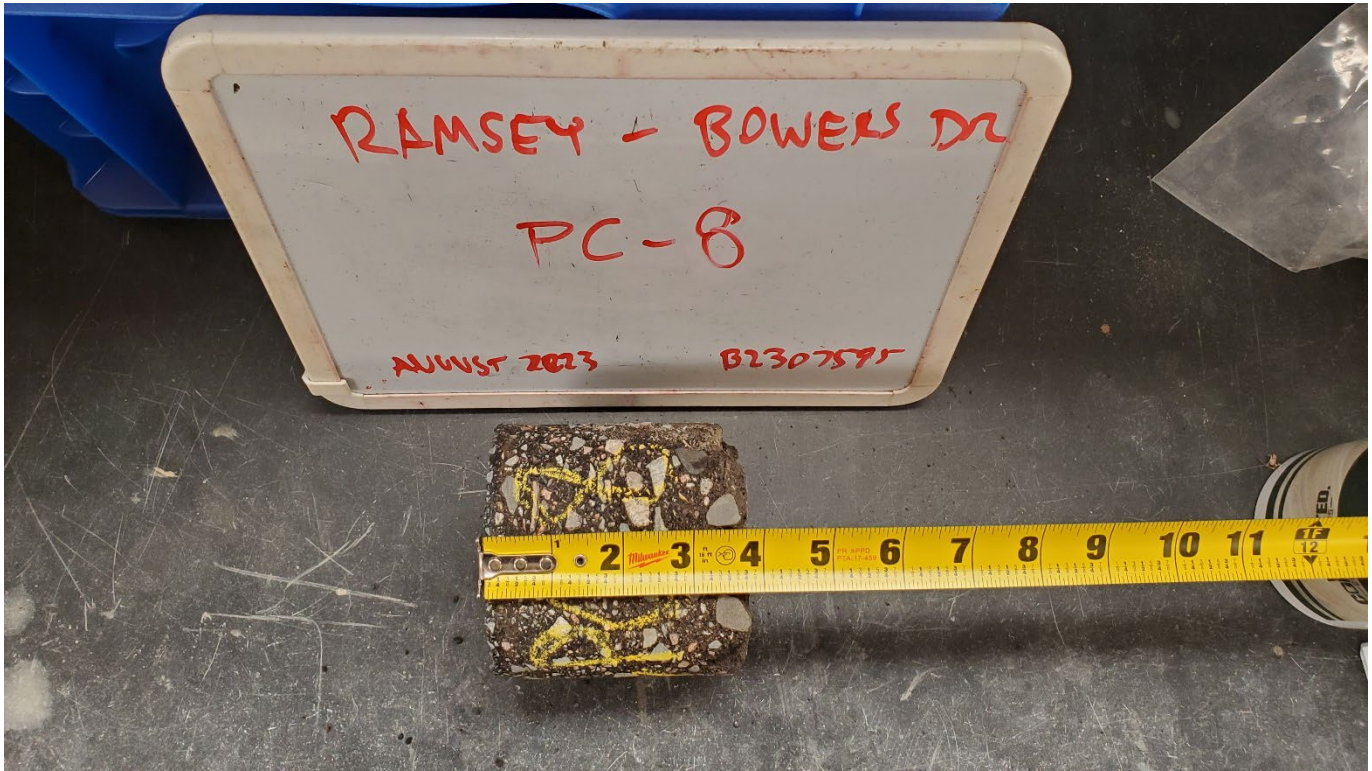
Core #:	PC-7			Project: B2307595 BRAUN INTERTEC
Pavement thickness	2 3/4 inches	Agg base thickness:	4 inches	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Side view



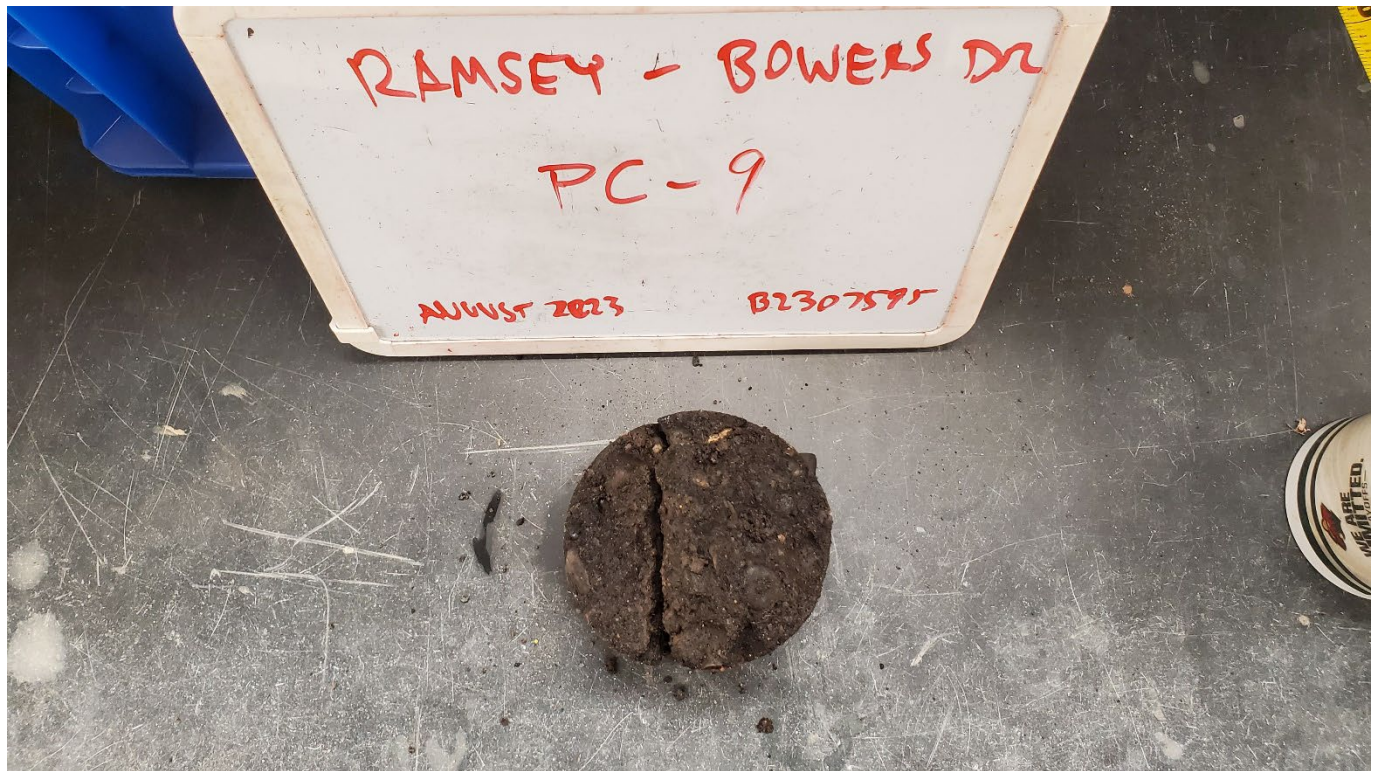
Core #:	PC-8			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	3 3/4 inches	Agg base thickness:	--	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Bottom view. No hand auger completed



Core #:	PC-8			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	3 3/4 inches	Agg base thickness:	--	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Side view. No hand auger completed



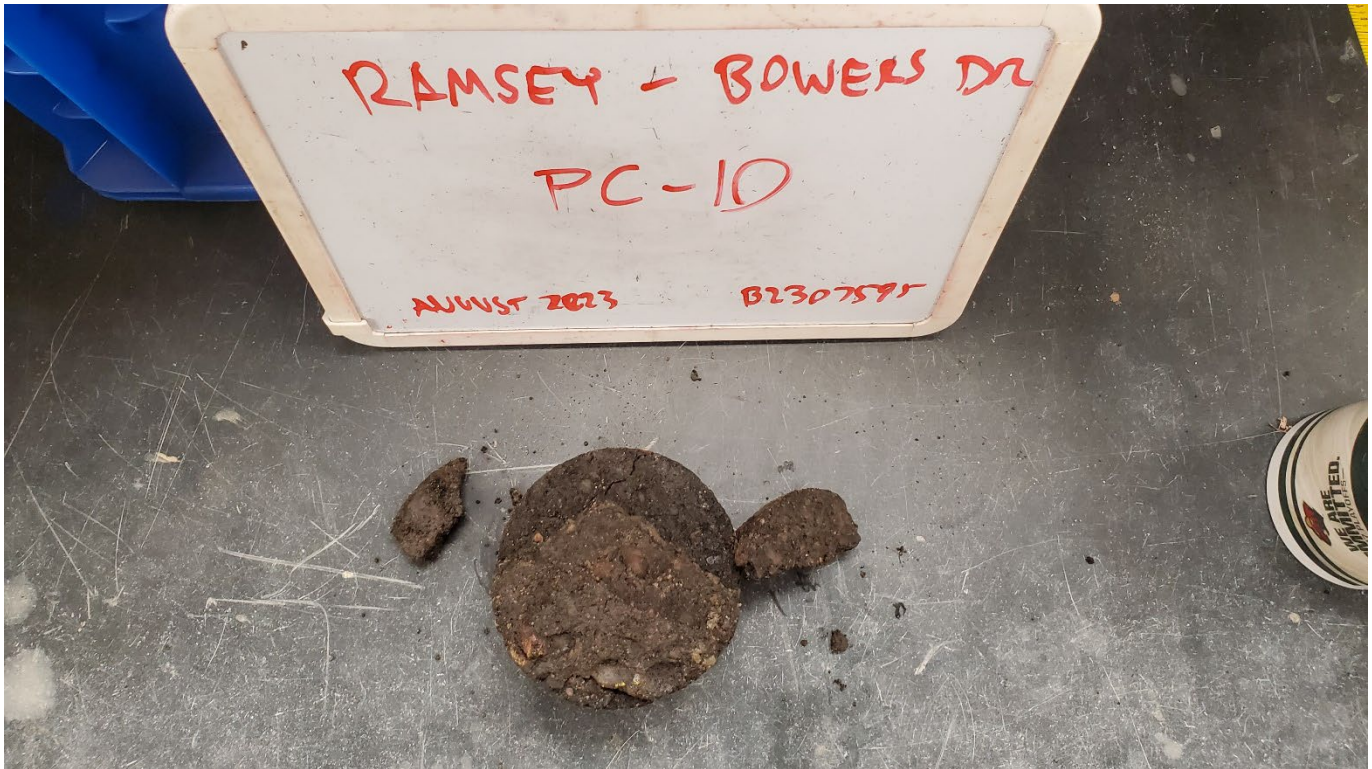
Core #:	PC-9			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	2 3/4 inches	Agg base thickness:	4 inches	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Bottom view



Core #:	PC-9			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	2 3/4 inches	Agg base thickness:	4 inches	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Side view



Core #:	PC-10			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	3 inches	Agg base thickness:	--	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Bottom view. No hand auger completed



Core #:	PC-10			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	3 inches	Agg base thickness:	--	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Side view. No hand auger completed



Core #:	PC-11			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	3 1/2 inches	Agg base thickness:	24 inches	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Bottom view



Core #:	PC-11			Project: B2307595 BRAUN INTERTEC
Pavement thickness:	3 1/2 inches	Agg base thickness:	24 inches	
Facility:	City of Ramsey - Bowers Drive			
Date:	August 2023			

Notes: Side view